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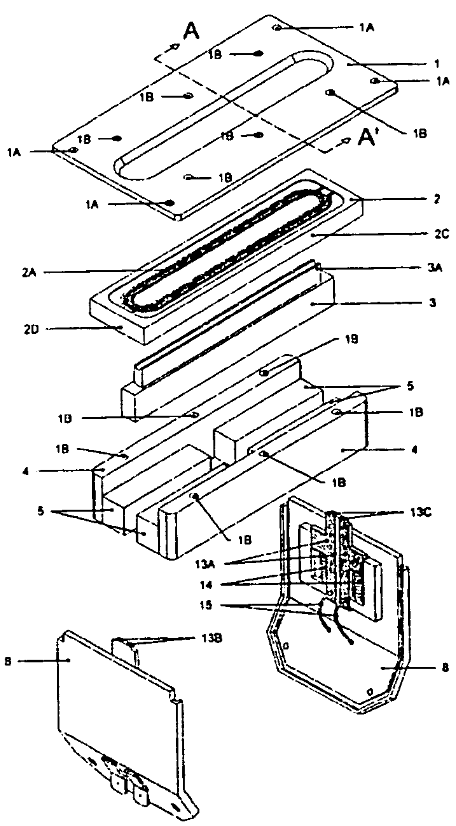
[Continued on next page]

(54) Title: ELECTROACOUSTIC TRANSDUCER WITH FIELD REPLACEABLE DIAPHRAGM CARRYING TWO INTERLACED COILS, WITHOUT MANIPULATING ANY WIRES



(57) Abstract: A diaphragmatic (planar) electrocoustic transducer forms a complete sound radiating transducer, with high efficiency and linearity. An easily exchangeable and rectangular in shape diaphragm, of very thin polyamide film is made with a plurality of aluminum conductors formed on one side of said diaphragm. The diaphragm with the plurality of conductors form two identical and symmetrical coils which are the one, inside the other, in an order, that conductors of each coil are interlaced. The two sections of the coils are disposed in dense air - gaps of the magnet system, which comprises a plurality of high (BHmax) Neodymium magnets. The binary interlaced coils can be utilized in a number of modes, for the purpose of accomplishing a variety of operating modes, such as: 1. A series connection provides a higher sensitivity compared to single coil (2). A parallel connection converts the transducer to a higher power standing devise (3). A single coil driving mode, leaves the other coil to be used as magnetic damping devise for the whole diaphragm (4). Moreover a single coil driving, allows the utilization of the other coil to be as source of correcting feedback circuitry (5). The symmetricity and the similarity of parameters of the two coils can be exploited in push-pull output stages for linearising purposes (6). In addition the two coils can be used in direct digital loudspeaker circuitry. The above described operating modes, are merely illustrative of the varied possibilities which may constitute applications of the invention's binary interlaced coil configuration. The binary interlaced coils of the present invention can be executed with a multiplictiy of such coils, laid on the same diaphragm, for accomplishing long line source loudspeaker. Such other application may be devised by those skilled in the art, exploiting the possibilities offered by the two identical and symmetrical coils.

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ELECTROACOUSTIC TRANSDUCER WITH FIELD REPLACEABLE DIAPHRAGM CARRYING TWO INTERLACED COILS , WITHOUT MANIPULATING ANY WIRES

This invention relates to electroacoustic transducers which act as Loudspeakers and in particular to thin diaphragm type of Audio transducers, which are converting electrical (audio) energy, into movement of a sound emitting diaphragm.

Such transducers which are called Planar Loudspeakers or some times as Ribbon Loudspeakers, in the past years were not enjoying the same popularity as the cone-type speakers -inspite of the superior performance of the said diaphragmatic types- due primarily their high cost, and the different performance characteristics.

The conventional, cone or dome Loudspeakers are known as electromagnetic motor actuated point sound source emitting devices.

As it is known to those skilled, in the art of sound reproduction, the" pistonic " operation of cones or domes is not at all secured throughout their operating range, and as a result not a uniform sound emitting activity can exist from the surface of cone or dome. Sound waves emitted from the peripheral portion of cone or dome may be out of phase to the emitted sound, from their central part areas, at any given instant. This is an inherent distorting characteristic of cone-dome Loudspeakers, created by the mode of activation and the shape of the activated sound emitting surfaces. An additional distortion producing factor, is the moving mass of cone or dome which has to be moved in accordance with the waveform of the audio current.

The demands of the audio signal, can be so great in terms of moving speed and acceleration, that (the inertia mass) weight (mass) of the vibrating parts is a great limiting factor. As a result the reproduced waveform is greatly affected especially in high frequencies where the relative inertias cannot be met by the electromagnetic motor moving the heavy cones or domes.

The above severe limitations, of the motor actuated Loudspeakers, such as kinetic sluggishness; shape and mass, are certainly, overcomed, by the thin diaphragm type of loudspeaker, which employ as sound emitting surface a diaphragm of greatly reduced mass and the moving force is applied on almost all the area of the vibrating diaphragm, thus realizing a true pistonic vibration action. The low mass of the diaphragm obeys the commands of the audio waveform with exceptional ease and the acoustic results are extreme fidelity, and transparency.

Numerous type of such planar speakers can be found, being used in Hi Fi systems, giving very satisfactory acoustic results. Most of the planar transducers existing in commercial production today make use of Polyester or Polyimid diaphragm which has on its surface laminated a very thin layer of parallel aluminum current carrying conductors. The said diaphragm is evenly stretched over rows of magnets, the magnetic lines of which, intersect the diaphragm with current currying conductors at 90°. The interaction of the magnetic lines and the magnetic field created by the current flowing the conductors, results in a force, moving either forward or backward the diaphragm in accordance with the direction – at any instant- of the flowing audio current.

Thus, the diaphragm with the current carrying conductors is the motor and the sound emitting member of the Planar loudspeaker.

Such planar loudspeakers are characterized by distinct advantages in performance over the cone-dome loudspeakers. Planar loudspeakers exhibit, wider bandwidth, Linear phase response, constant impedance, greatly improved transient response and lower distortion .

All those operating advantages are the reasons of the acoustic superiority of Planars. Especially, with today's digital sources of audio reproduction such as CD, DVD-Audio, SACD (Super Audio CD), DAT etc. which place higher demands on the contemporary loudspeaker systems, the said advantages are invaluable. However all those acoustic benefits offered by planar magnetics are enjoyed by audiophiles, after paying the high cost, for the said loudspeakers.

The high cost of the planar loudspeakers is somehow anticipated, considering their distinct acoustic merits. The disappointment of the user comes, when the delicate vibrating diaphragm happens to fail, either by mechanical failure or by thermal failure of the coil. In such situation, all the rest expensive structure of the planar loudspeaker is wasted as laying inoperative.

Invariably such planar Loudspeaker failures are not remediable by the user. Under the circumstances the magnetic structure and in fact the entire loudspeaker which has been paid dearly, becomes total waste. Even in the rare case of loudspeaker makers allowing return to factory for repair, the user must pay dearly for material, labor and transportation.

Primary object of the present invention is to provide a planar sound reproducer with excellent performance characteristics, the values of which are secured, and maintained at all times by offering :

(A) The exchangeable diaphragm may carry multiplicity of binary interlaced coils.

The advantages of the binary interlaced coils, of this invention, and their applications will be exposed extensively in the text to follow.

(B) An easy and simple way of replacing the diaphragm, by the user, in the filed, without the need to manipulate any wires and soldering-disordering tools in case of failure, or, in case of installing diaphragm with different characteristics.

(C)The exchangeable diaphragms in a variante of resistance - impedance characteristics.

(D)The whole surface of the binary interlaced coils being driven, in the true sense of word driven. In order that the present invention may be more fully understood, the made statements A, B, C, D will be elaborated and with the help of accompanying drawings fully elucidated.

In the present invention the replacement of the diaphragm is accomplished by the user in a very simple operation, without the need of manipulating wires or soldering- de-soldering means, as this is necessary in prior art equipment.

In the prior art, the diaphragm of commercial planar speakers employ for driving, single coil, in contrast, with the present invention which provides two (binary) interlaced coil , for simultaneous driving. In the present invention, in addition to the easy field replacement, the diaphragm is characterized by two symmetrical coils configuration, which are interlaced, in a manner of being the one into each other, thus occupying the same area of the said diaphragm and securing the fact that the two coils are absolutely identical with all electrical characteristics such as Resistance, Impedance, Inductance being absolutely equal. Such Binary Interlaced Coils can be laid, in a multiplicity of similar B.I.C. executions, on the same long diaphragm tensioning adjustment means, for obtaining desired low frequency operation. A long and slim loudspeaker embodying in its diaphragm a multiplicity of binary interlace coils, can lead to the design of full range hybrid speaker driver, with line source behavior. The two coils in the present invention are characterized by symmetricity and equality of their parameters, a condition which permit the creation of several combinations of impedance networks, which can act as the output loads of an amplifier:

It is an objective of the present invention to provide to those skilled in the art of sound reproduction, the flexibility of connecting, in series the two coils for maximum sensitivity or in parallel for increased power capability. Additional connecting possibilities of the two coils are as follows :

Two terminal networks	Four terminal networks
• Single coil operation	• Two winding transformer
• Double coil series operation	• Two winding auto transformer
• Double coil parallel operation	• Two winding push-pull configuration

In addition, the invention of binary symmetrical interlaced coils configuration can inspire and provide the means, to those skilled and wishing, to devise new applications such as :

A) DDL. Direct Digital Loudspeaker circuitry

B) Feedback optimizer circuitry

C) Magnetic damping circuitry

D) Crossover at two different frequencies

E) Push - Pull circuitry

F) Long line source loudspeakers

G) Other inventive applications

An other object of the present invention is the character of the exchangeable diaphragm assembly and the way the totality of the coils conductors are energized by the magnetic field.

Specifically, the semicircular sections of the interlaced coils, which are at the two ends of the longitudinal axis of the diaphragm are not clamped, but free to move, and in addition the semicircular section of the conductors are intersected by the magnetic flux lines exactly as the linear section of the conductors.

Thus effectively driving the semicircular sections, in strict accordance with the excursions of the linear sections, therefore the entire area of the coils is moving in a true pistonic action.

The Ampère's Law for the force on a conductor, it asserts that any conductor of (L) length carrying a current (i) and located in a magnetic field (B) at right angle to the flux lines, will be pushed by a force (F) that is proportional to the flux density, to the current and to the length of the conductor. The above principle is mathematically expressed as : $F = BLi$, F, B, i being vector quantities. This is the principle that governs the force which moves the diaphragms of all planar speakers.

In applying Ampère's Law, it should be noted that for any length (L) of conductor the directions F, B and i are **mutually perpendicular**.

Fig (5) shows these directions along the three geometric axes, as the Law is examined in three points along a typical turn of our diaphragm, where is confirmed that the Force (F) has the same direction in the linear and the semicircular section of the conductor, thus the semicircular section is actively contributing in the sound emitting activity

By using **Fig. 5** it is clearly shown that the Ampère's Law is applied in all the length (L) of our diaphragms conductors.

The various diaphragmatic loudspeakers of prior art invariably have the extreme sections of their elongated coils, not actively participating in the force producing process, and in some cases they are clamped and immovable.

With reference to a U S patens No 5,003,610 titled :

" Whole surface driven speaker " assigned to Fostex corporation, Japan , the following comments should be made :

The claim of the title that the entire surface is " driven " does not seem correct, because there are sections of diaphragm coil extremities which actually are not driven and are not force producing sections, Those sections, **Fig. 3** of the 5,003,610are simply carried out by the rest of the active linear sections, which are force producing , obeying the Law F= BLi.

With reference to drawings and more particularly to **FIG. 1**,is shown all the main components ; which compose the present invention and which are : the upper plate pole **1** , the diaphragm assembly **2,** the central pole **3**, the side poles **4**, the Neodymium magnets **5**, which are required for the construction of diaphragmatic electroacoustic transducer in accordance with the present invention. The members **1, 3, 4** are made of low carbon soft iron material **FIG 2** shows the components **1, 2, 3, 4, 5,** assembled and the created two air gaps **22,** between upper plate pole **1**, and the central pole **3**.. **FIG. 2** shows the complete transducer assembly installed in its aluminium enclosure **6,** as indicated in Line A – A' cut of **FIG. 1, FIG. 2A** shows in perspective view, the complete loudspeaker assembled and the two covers **8** being in place, thus realizing the contact of each coil of the diaphragm, with the respective terminals **16** outside of each plastic cover **8** .

In **FIG. 1** the upper plate **1** is machined in highly polished surfaces for low magnetic losses when attached by six screws **1B** to side poles **4**. Following this attachment of **1** to **4** , the Neodymium magnets **5** together with the central pole **3,** are put in place, with appropriate adhesive agent. This assembly procedure always takes care that the upper plate **1** is the South pole of the magnets and the central pole **3** is the North pole. By

convention we consider that the direction of magnetic flux lines have a direction from N- to - S as indicated in the analysis of **FIG. 5** .

By referring to **FIG 2** , and in particular to the groove **23** of the upper part of the central pole **3**, it should be given the two reasons of the groove **23**. At first the flux lines traversing the air gap **22**, are mostly departing from the two banks **21** , of the groove **23** and , very few lines departing from the bed **23** of the groove. If the groove geometry is examined in conjunction with geometry of the two interlaced coils will be apparent that the central section of the diaphragm **2A**, is not covered by coil conductors and therefore any lines intersecting that section are a waste. Also any lines reduced from departing the inner part of the groove **23** of the central pole **3**, are added to the useful part of flux lines departing from the groove banks **21** . An additional usefulness of the groove is the filling of the bed by a soft wool thread, which is " overflowing " the bed, and thus at extreme excursions of the diaphragm, the wool thread acts as acoustic bumper.
By referring **FIG 1** to the pieces **1, 3, 4** and **5** assembled , the magnetic system is ready to accept the exchangeable diaphragm assembly **2**. The diaphragm assembly **2** is inserted in its operating position by holding the frame from the side **2D** and sliding the long sides **2C** between the poles **4** and the short side **2B** with the opening, better showing in **FIG 4** , allowing the passage, without the thin part **3A** of the central pole **3** being an obstacle.

Referring **FIG. 1** the magnetic assembly , which comprises an upper plate pole **1** , a center pole **3** the side poles **4**, the Neodymium magnets **5**, can now be inserted in the aluminium enclosure **6** and fixed in place by four hexagon headless screws **1A** threaded on the upper pole **1**. As shown in **FIG 2B**, by screwing each **1A** against the internal surface of the front part of the aluminium enclosure **6** , the upper pole **1** squeezes a ferrous metal sheet **7** which acts as magnetic shielding and at the same time it immobilizes the magnetic assembly inside the aluminium enclosure, by anchoring it in four different points **1A** x 4, as per **FIG. 1** , **FIG. 2A** .
With the magnetic assembly inside the enclosure **6** and fixed, the diaphragm assembly **2** shown in **FIG 3** and **FIG 4** is in its operating place **FIG. 4**, ready to accept the spring loaded contacts **13** , **13C** which are better shown on **FIG** 1 and realize their electrical access from the outside contacts **16** . In **FIG 3** are shown the two pairs of contact islands **9, 9A** and **10, 10A** corresponding to the two interlaced coils **11** and **12** respectively.

In order to understand the automatic contacting of the external terminals **16** with the two coils **11** and **12** of the exchangeable diaphragm **2** as shown in **FIG 4**, is necessary to review the functioning of the transducer covers **8**. Both covers are identical plastic pieces and are airtightly closing the inside of the loudspeaker. This is accomplished by providing a soft gasket material which is placed at the bottom of guiding groove **17**. The guiding groove **17** is playing another role, which is riding on the edge of the aluminium enclosure during the closing operation, guides the cover to its final closing position, at which should be precisely making the electrical contact operation. The inside of each cover is characterized by the two spring **14**, the spring loaded contact carrier **13** which is cross shaped and which is a copper clad material, as that used in printed circuit boards, of 2 mm thickness.

The contact carrier **13** is separated in two contacting copper areas **13A** along its longitudinal dimension, on the one side having soldered the pair of gold plated contacts **13B**, **13C**, **FIG. 1** and on the other side are attached by soldering, one pair of flexible conductors **15**, the free ends of which are soldered on the inside riveting member of the terminals **16**, supported on the outside of the cover plastic cover **8**.

FIG. 4 shows by dashed lines the path or routing of the spring loaded contacts and the eventual contact with contact islands **10, 10A**, which takes place at the end of the transducer covering operation. The spring compression of both covers, applied on each extremity of the diaphragm assembly **2**, through the contact islands **9**, **9A** and **10, 10A** besides the electrical contact making action, they hold firmly the diaphragm assembly **2** to its proper operating position. This position bring the two coils at 0.6mm below the lower surface of upper plate **1** and 0.6mm above the two banks **21** of the central pole **3**. With the help of **FIG. 5** and the Ampêrs law we shall expose the electromagnetic force F which is exerted on typical conductor turn of our coil, and prove that every part of the coil, linear and semicircular, is driven by a unidirectional force at any instant and that the **whole** coil surface is driven in strict accordance with the driving audio signal.

The force F in dynes which drives the conductors of the two interlaced coils, is expressed in mathematical terms as : $F = BLi$, where

B = Flux density of magnetic lines in Kilo - Gauss, arrows **19** indicate the direction of flux lines

L = the length of the conductors in Meters

i = the current in the coil in Ampêrs arrows **20** indicate the direction of current in the conductor

F = the force in dynes resulting from the interaction of B and i arrows. F indicates the direction of the force

The quantities F, B, i are vectors and according to Ambêr Law are mutually perpendicular. **FIG 5** shows the three vectors F, B, i along the three geometric axes, applied in points along the linear sections of the coil **24** as well as the semicircular sections of the coil **24** , where the perpendicularity of **B** and the direction of i is applied on the tangent on the application point.

It is clearly shown that with vectors B and i unchanged in direction, at any instant , the resulting force vector **F,** as applied in three different points on a coil 's conductor turn, is of the same direction .

It is therefore clear that the **whole** surface which is covered by the two interlaced coils are moving by force **F** in exact accordance with the audio signal., pistonically.

BRIEF EXPLANATION OF THE DRAWINGS

Fig. 1 An exploded view illustrating the components of the Planar Loudspeaker at its first embodiment of the Present invention.

Fig. 2 Sectional view taken through cut line A- A' of Fig. 1 with the Planar loudspeaker components, being in the assembled Position, and installed in the aluminum enclosure.

Fig. 2A Perspective view of the complete planar loudspeaker assembled in the aluminum enclosure and the two covers in position.

Fig. 2B A fragmentary enlarged view of upper plate and aluminum enclosure showing the way of fixing in place the complete transducer inside the aluminum enclosure

Fig. 3 Top view of the exchangeable diaphragm assembly, showing the second embodiment of the present inventions the binary interlaced coils 1 and 2 .

Fig. 4 Perspective view of a third embodiment showing the contact island and the spring loaded mating contacts approaching.

Fig. 5 A fragmentary enlarged view of a portion of the diaphragm's conductor, being exposed in the influence of magnetic Field in the air gap and the unidirectional forces, acting to all portions of the coil

CLAIMS

The claims defining our invention are as follows :

1) A thin diaphragm of elongated two (binary) interlaced coil electroacoustic transducer for use as loudspeaker, characterized by field replaceable sound emitting diaphragm without the need to manipulate wires and comprising :

a) A magnetic system which comprises an upper plate pole, **1** the two side poles **4** the central pole **3** and the row of Neodymium magnet bars **5** .Two air gaps **22** formed between the upper plate pole and central pole. The magnetic lines transversing the gap, create a high density field .

b) A thin foil diaphragm carrying thin aluminum conductors formatting at least one binary interlaced coil, **11** and **12**, built the one into each other, and which are situated substantially in the plane of the magnetic lines transversing the air gap **22** and the conductors of the diaphragm, being crossed by the same intensity of flux lines perpendicularly , at the **totality** of their length, where, the application of F=BLi gives the same force F.

c) A diaphragm sound emitting assembly , **2** comprising a frame made of non-ferrous sheet metal, on which is tensioned a vibratable very thin diaphragm **2A** of high temperature polymer on which are formatted a multiplicity of two elongated coils **11** and **12** of aluminum foil, which are identical and symmetrical., interlaced the one into the other.

2) A thin diaphragm electroacoustic transducer as claimed in claim 1, in which the said diaphragm is carrying a double coil **2A** configuration, is adhered along the periphery of the frame and the elongated conductors of the two coils are terminated in two aluminium foil conducting islands, **9-9A** and **10-10A** each are symmetrically located at the extremities of the said diaphragm assembly **2**.

3) A diaphragmatic electroacoustic transducer as claimed in claim 2, in which the said conducting islands, when the diaphragm assembly **2** is properly inserted inside the transducer, are situated in the routing or path of pair of contacts **13B** and **13C** which are spring loaded, and supported on the sliding covers **8** , thus at the end of the sliding route of each cover, two spring loaded contacts are pressed against the two mating conducting islands **9-9A** and **10-10A** .

4) A diaphragmatic electroacoustic transducer as claimed in claim 3 in which spring loaded contacts **13B** and **13C** are gold plated at their tip and soldered on the sliding cross shaped contact carrier **13**, which is made of copper laminated Bakelite sheet.

5) A diaphragmatic electroacoustic transducer as claimed in claim 4 in which the copper laminated sheet is separated in two conducting surfaces **13A** one for each contact. The one end of the cross, shaped contact carrier **13**, are soldered two flexible conductors of which their other end are soldered on the riveting member of the loudspeaker terminal.

6) A diaphragmatic electroacoustic transducer as claimed in claim **5** in which when the diaphragm assembly **2** is to be replaced, by removing the two transducer covers **8**, the diaphragm assembly is free to be withdrawn.

7) A diaphragmatic electroacoustic transducer as claimed in claim **6**, in which the new diaphragm **2** is inserted, and the connecting of the two coils **11 and 12** with the corresponding terminals **16**, is accomplished simply by reclosing the transducer's upper and lower covers. This reclosing action, by the covers **8**, automatically terminates the one coil on the upper terminals and the other on the lower terminals **16**.

8) A diaphragmatic electroacoustic transducer as claimed in claim **7**, in which the replaceable diaphragm and frame integral unit **2**, provides another advantage, which relates with the percentage of its area being actively driven by the audio signal. The two semicircular sections of the coils are free to vibrate, and the audio current flowing in that semicircular section of each coil is actively contributing in the sound producing process, in the same procedure as the linear sections of the coil, thus substantially increasing the transducer efficiency.

9) A diaphragmatic electroacoustic transducer as claimed in claim **8**, in which the central pole **3** profile cut, shape, which resembles a dry river **23** with its two banks **21**, and reduces the number of useful magnetic lines crossing the center part of the diaphragm which is empty of conductors. The reduced lines from departing the bed of the river, are added to those crossing usefully the active gap **22** area and crossing the coils' conductors.

10) A diaphragmatic electroacoustic transducer as claimed in claim **9** in which the shape of central pole, where its upper part groove, serves also the purpose of accepting an elongated soft material that overflows the groove which acts as bumper for the diaphragm, during high amplitude excursions.

11) A diaphragmatic electroacoustic transducer as claimed in claim **10**, in which the binary interlaced coils **11-12** of its diaphragm, can be utilized in a number of modes, by

those skilled in the art of sound reproduction: a) In series connection for increased sensitivity, b) in parallel connection for increased electrical power handling ability, c) furthermore for developing such applications as crossover in two different frequencies, d) DDL Direct Digital Loudspeaker, e) feedback optimizer circuitry, f) magnetic damping circuitry, h) two winding push-pull configuration, h) other inventive applications.

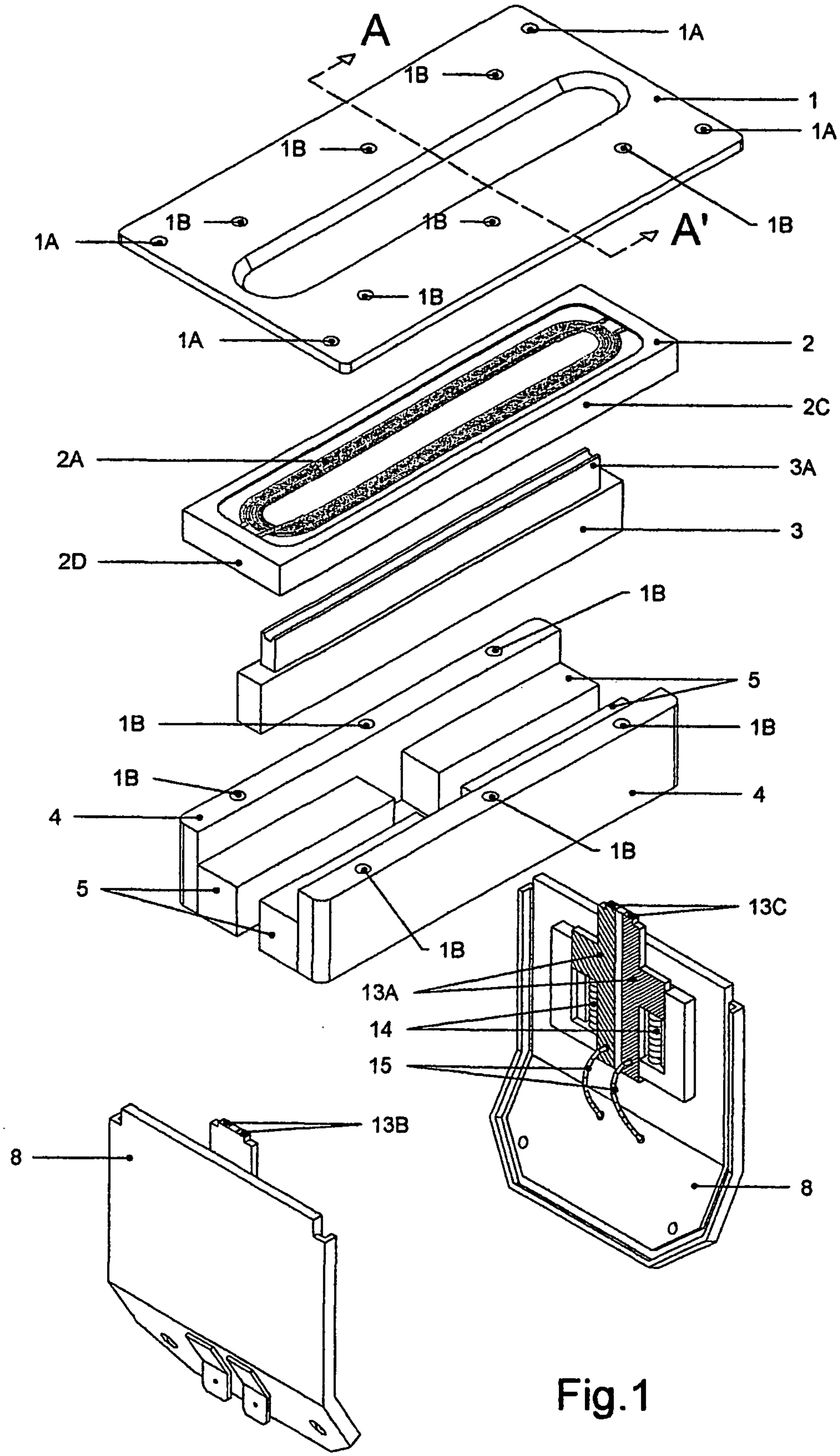
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Fig.1

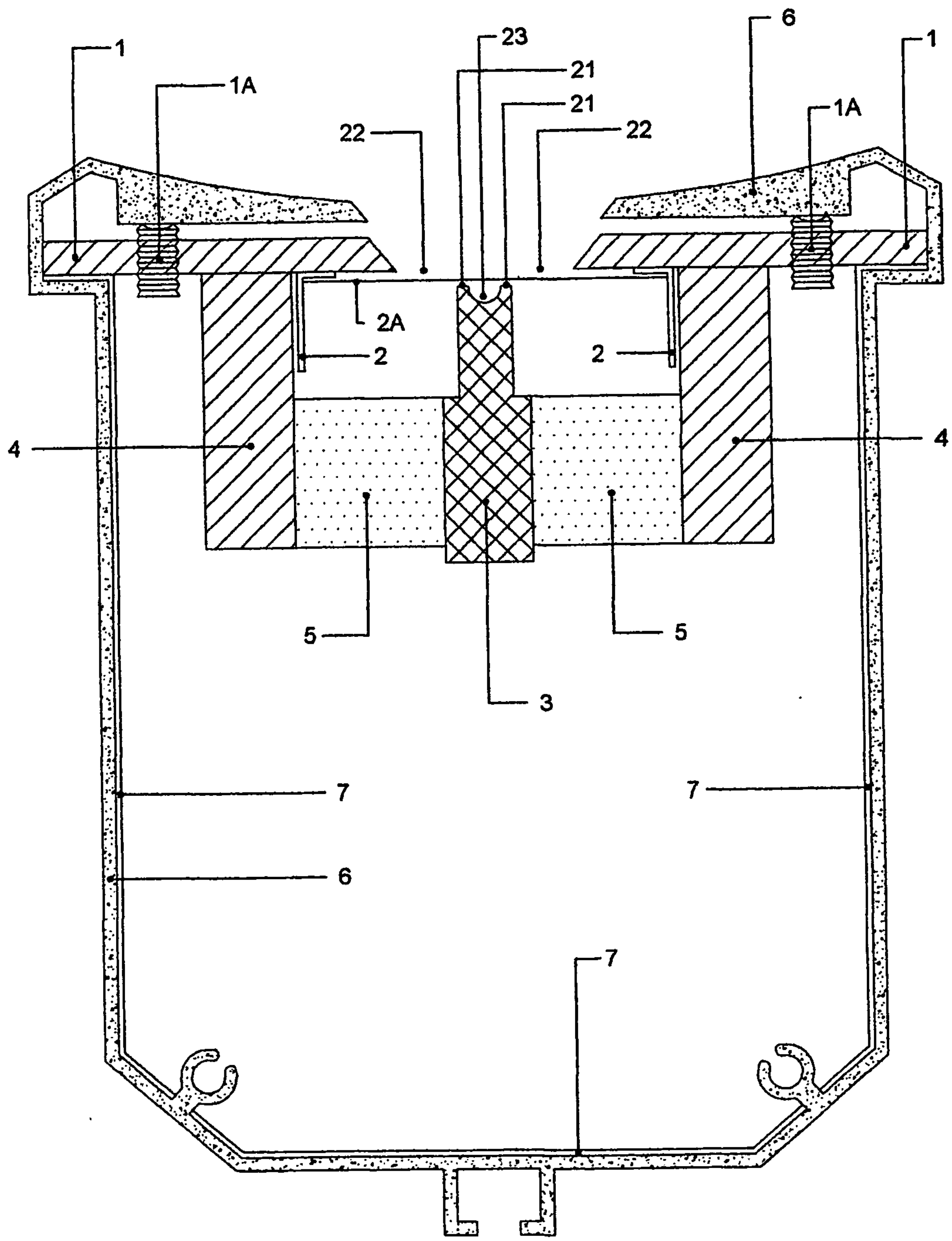

Fig. 2

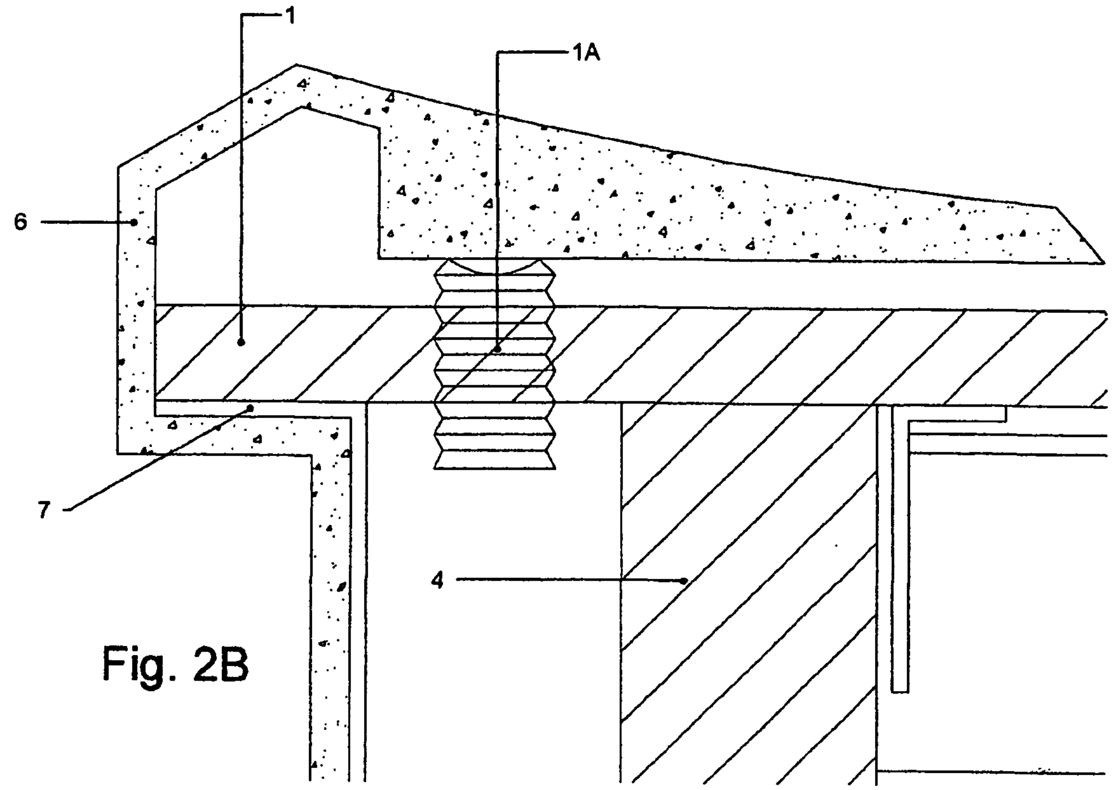

Fig. 2B

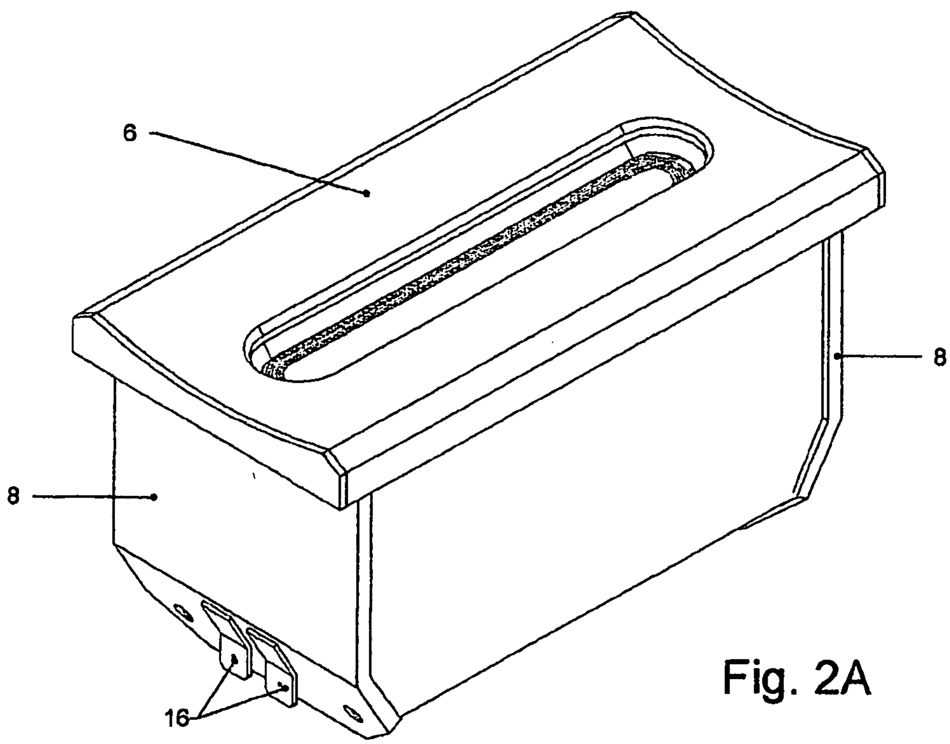

Fig. 2A

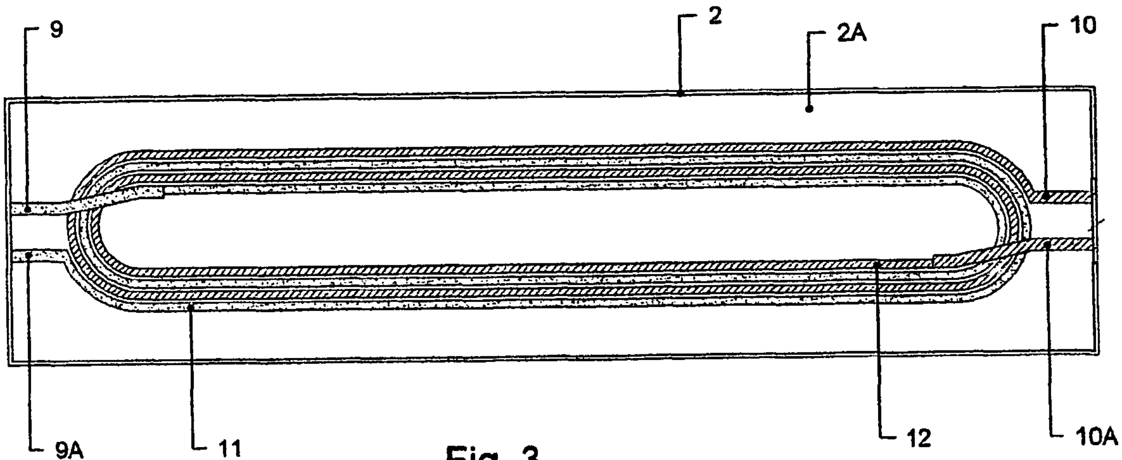

Fig. 3

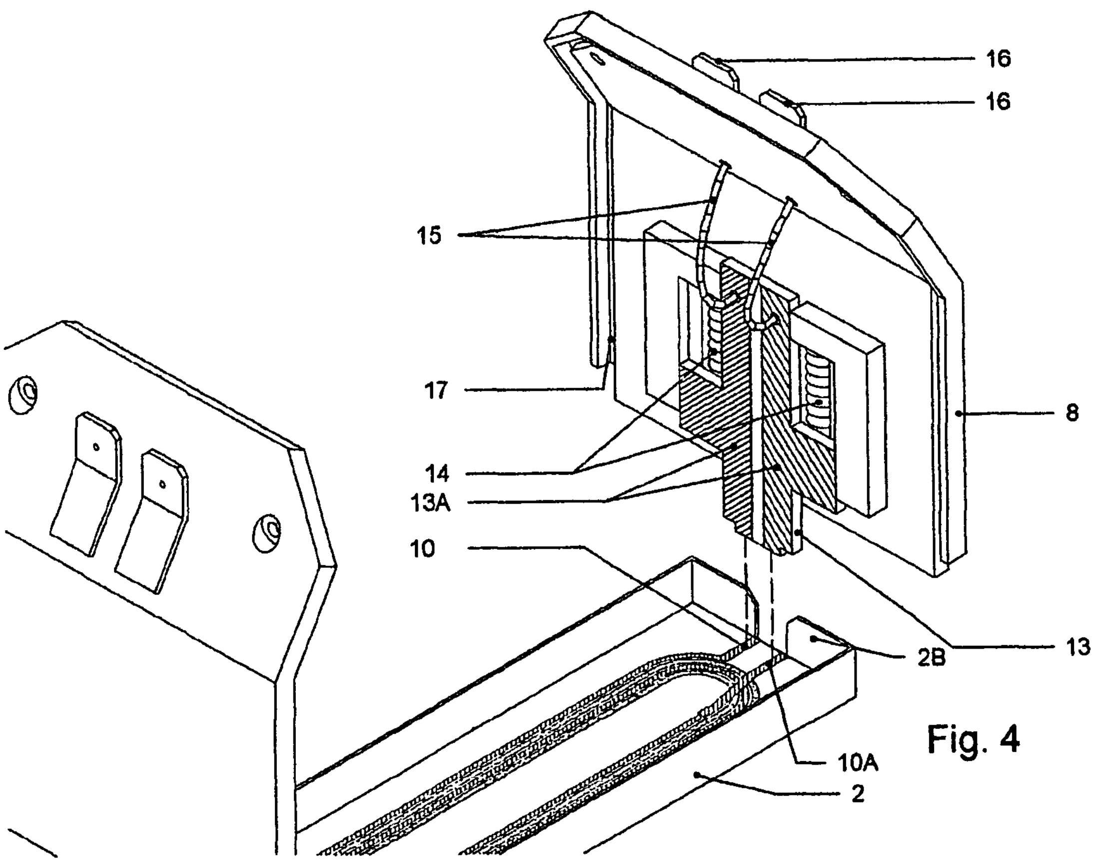

Fig. 4

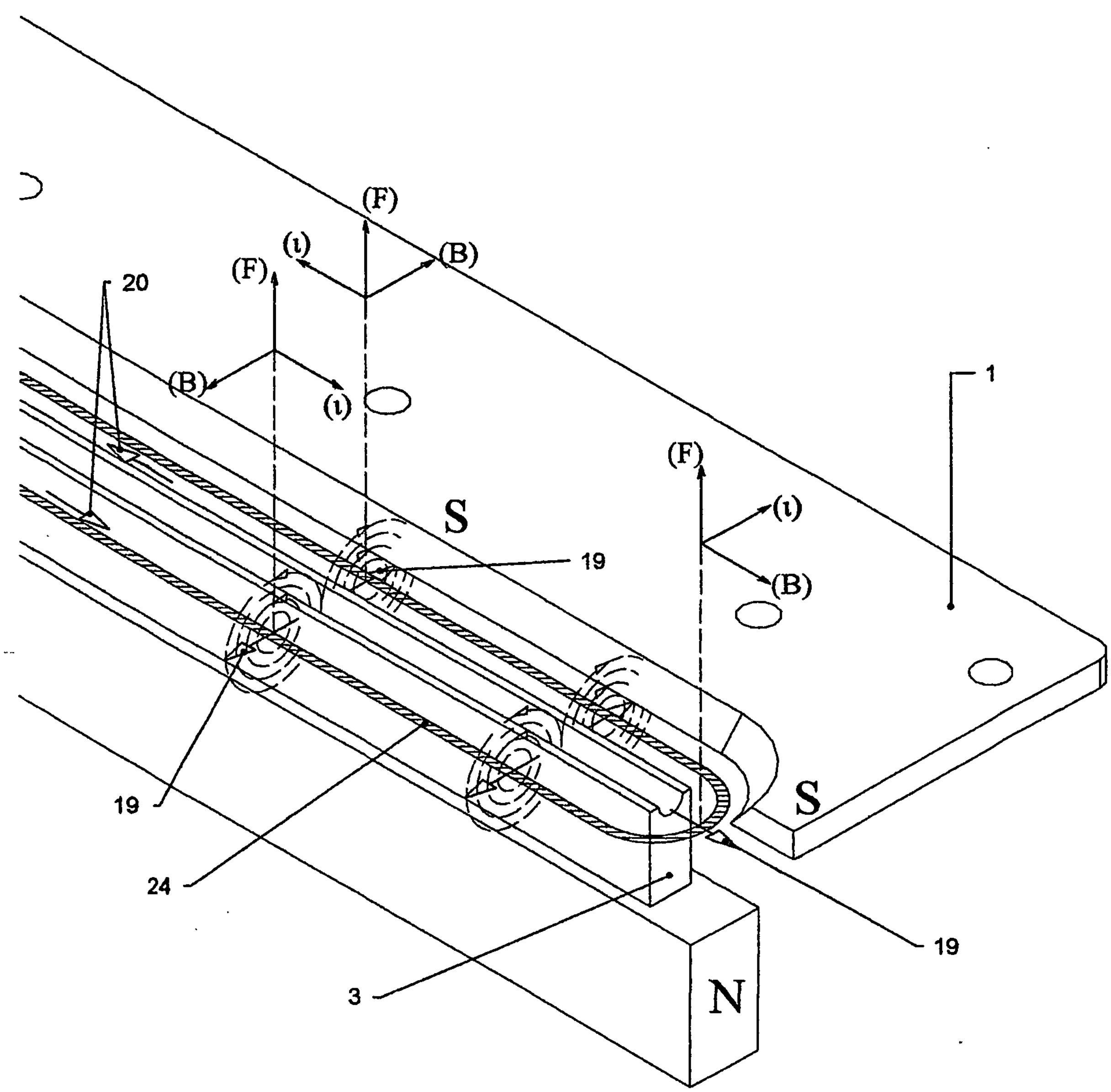

Fig. 5

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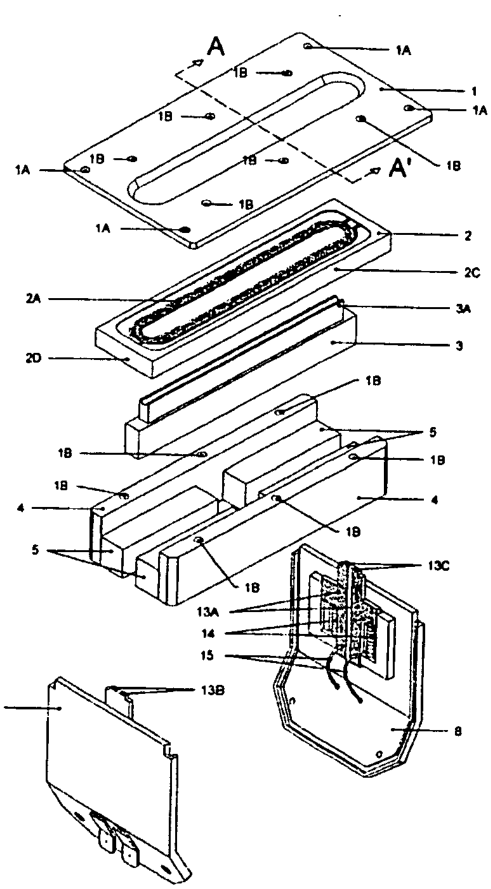
Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *with international search report*

[Continued on next page]

WO 02/003748 A3

(54) Title: ELECTROACOUSTIC TRANSDUCER WITH REPLACEABLE DIAPHRAGM



(57) Abstract: A diaphragmatic (planar) electrocoustic transducer forms a complete sound radiating transducer, with high efficiency and linearity. An easily exchangeable and rectangular in shape diaphragm, of very thin polyamide film is made with a plurality of aluminum conductors formed on one side of said diaphragm. The diaphragm with the plurality of conductors form two identical and symmetrical coils which are the one, inside the other, in an order, that conductors of each coil are interlaced. The two sections of the coils are disposed in dense air - gaps of the magnet system, which comprises a plurality of high (BHmax) Neodymium magnets. The binary interlaced coils can be utilized in a number of modes, for the purpose of accomplishing a variety of operating modes, such as: 1. A series connection provides a higher sensitivity compared to single coil (2). A parallel connection converts the transducer to a higher power standing devise (3). A single coil driving mode, leaves the other coil to be used as magnetic damping devise for the whole diaphragm (4). Moreover a single coil driving, allows the utilization of the other coil to be as source of correcting feedback circuitry (5). The symmetricity and the similarity of parameters of the two coils can be exploited in push-pull output stages for linearising purposes (6). In addition the two coils can be used in direct digital loudspeaker circuitry.

(88) Date of publication of the international search report:
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GR 01/00029

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04R9/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PATENT ABSTRACTS OF JAPAN vol. 010, no. 050 (E-384), 27 February 1986 (1986-02-27) -& JP 60 204199 A (TOSHIBA KK), 15 October 1985 (1985-10-15)	1
A	abstract	2-10
Y	US 5 003 609 A (MURAOKA KAZUYUKI) 26 March 1991 (1991-03-26) column 1, line 6-9	1
A	column 2, line 34-47 column 3, line 16 -column 4, line 41	2,5,11
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May 2002	07/06/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Zanti, P

INTERNATIONAL SEARCH REPORT	International Application No PCT/GR 01/00029

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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